Automated identification and characterization of the ITCZ using TRMM, GPCP, and ERA-Interim

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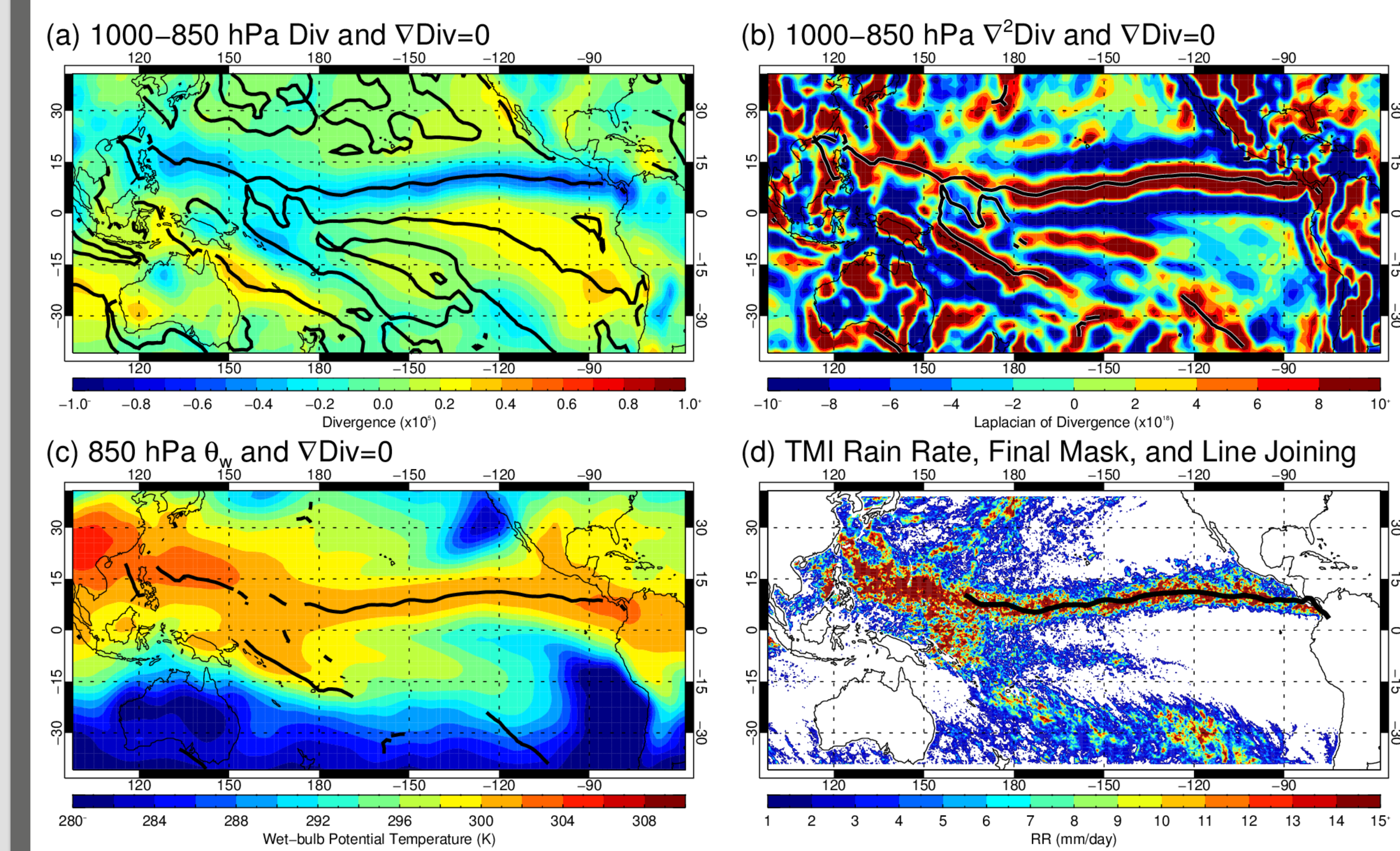
Motivation

Climate models show that modifying shallow convective activity in the subtropics controls the moisture transport into the Intertropical Convergence Zone (ITCZ). This sets the width and intensity of ITCZ convection through a series of feedbacks – the shallow-cumulus humidity throttle (Neggers et al. 2007). Before we can examine the relationship between the ITCZ, subtropical convection, and moisture transport, an objective set of ITCZ characteristics must be defined.

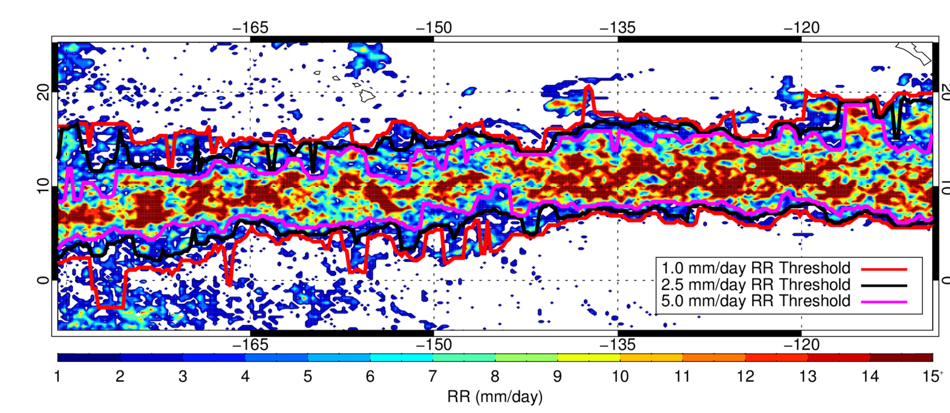
➔ *Here we develop an automated, objective algorithm that can be applied to any gridded observational precipitation and reanalysis combination or climate model dataset to identify ITCZ center location, width, and intensity.*

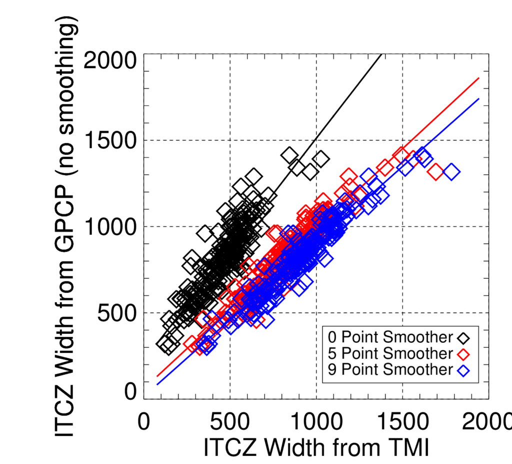
Data & Methods



Center ITCZ location identified in ERA-Interim using multistep process modified from Berry and Reeder (2014):

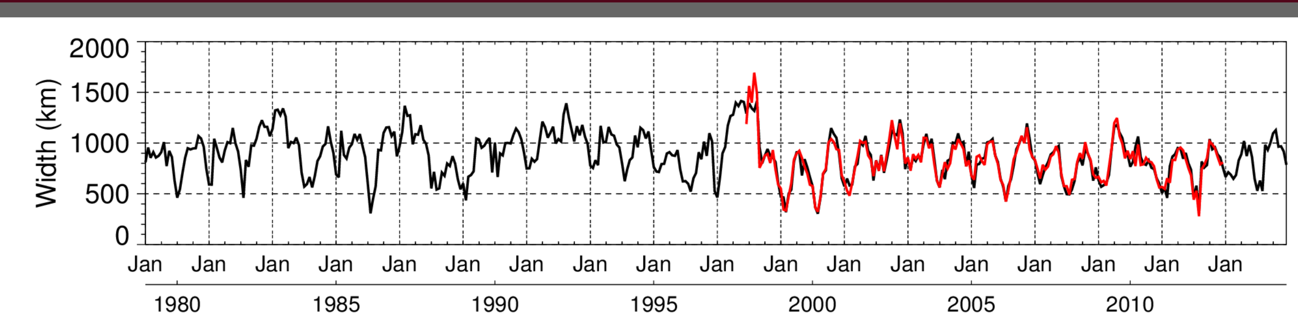
- Computed monthly mean 1000-850hPa layer divergence
- ∇Div = 0 used as initial ITCZ guess
- Divergence mask applied to remove divergence regions
- ∇^2Div mask applied to remove inflection points with ∇Div = 0 in non-converging regions
- θ_w (850hPa) mask applied to remove regions outside tropics

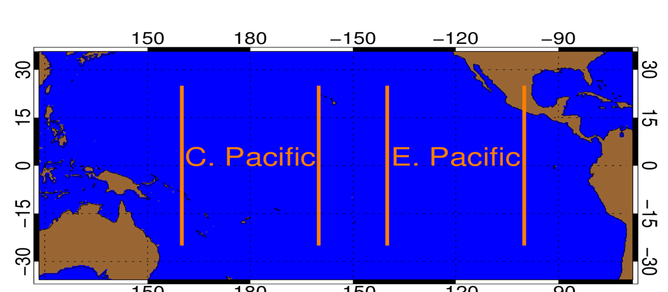




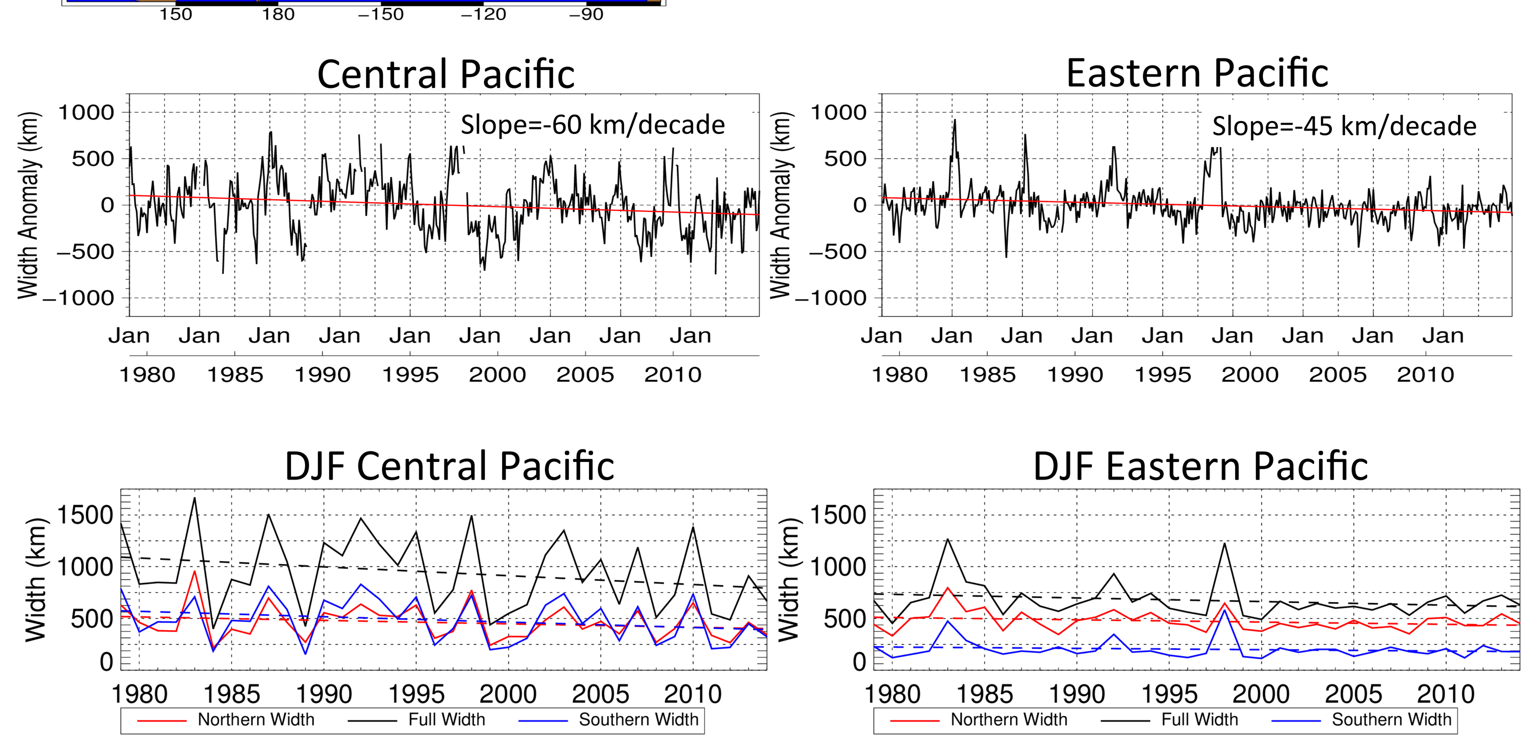
- Width determined by iterating from center to RR threshold
- Sensitivity tests between GPCP- and TMI-determined widths show 2.5 mm day^{-1} threshold has best agreement

ITCZ Width



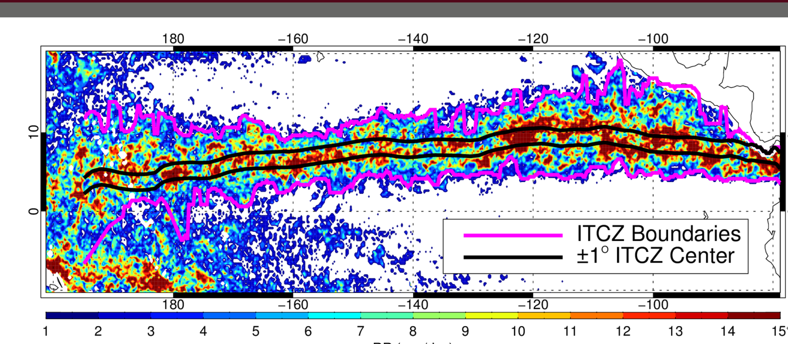


Central and east Pacific domains, corresponding to those of Waliser and Gautier (1993), are analyzed separately

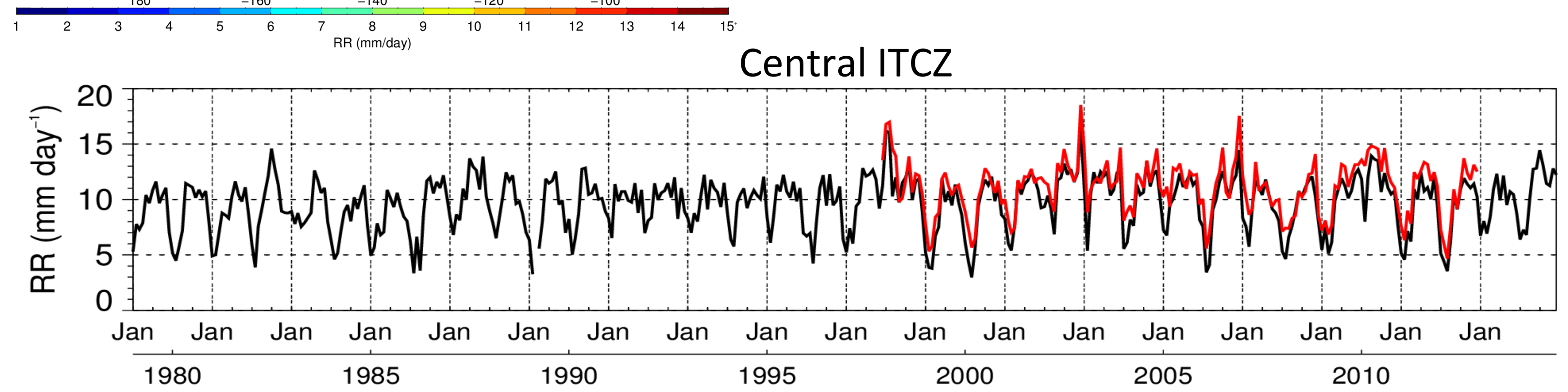


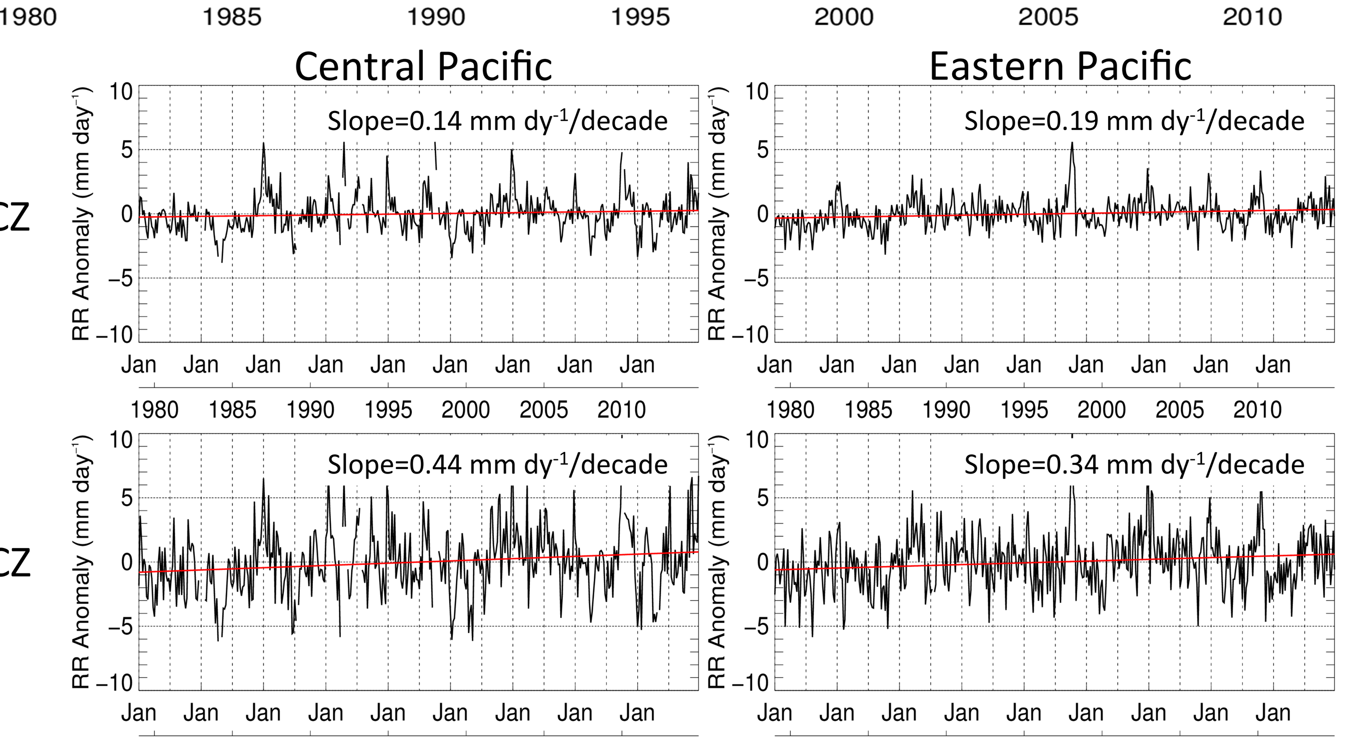
- ❖ *ITCZ has become more narrow*
- ❖ *Central Pacific ITCZ width decreasing faster than in eastern Pacific*
- ❖ *Less interannual variability after 'climate shift'*
- ❖ *DJF shows largest decreases in ITCZ extent*
- ❖ *Southern ITCZ extension decreases more rapidly than northern*

ITCZ Precipitation Intensity



Precipitation intensity over full ITCZ width and center of ITCZ are examined separately





- ❖ *ITCZ precipitation intensity is increasing*
- ❖ *RR near center of ITCZ shows greater increase than near edge*
- ❖ *Central Pacific precipitation increasing faster than east Pacific in ITCZ center*
- ❖ *Precipitation intensity increases during most seasons (not shown)*

Summary

Automated characterization of ITCZ using ERA-Interim and TMI or GPCP shows:

- ITCZ has become more narrow while precipitation intensity has increased, especially in the central Pacific
  - Largest changes are in boreal winter
  - Greater precipitation increases in center of ITCZ, suggesting more intense deep convection
- Evidence of 'climate shift' in ITCZ extent, but not in precipitation intensity

Future work

Can we relate ITCZ narrowing and intensification to cu-q throttle mechanism?

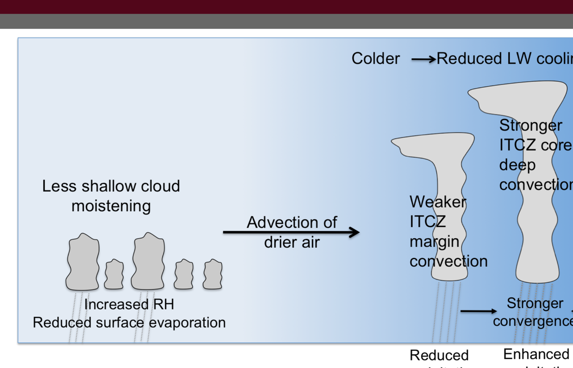


Figure adapted from Neggers et al. (2007)

- ➢ Analyze precipitation features within the ITCZ
- ➢ Examine relationship between subtropical convection, moisture transport, and ITCZ characteristics

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